STATEMENT

I, Makoto KONDO, of c/o NGB Corporation, ARK Mori Building 13F, 12-32, Akasaka 1-Chome, Minato-ku, Tokyo 107-6013 Japan, hereby state that I am conversant with both the English and Japanese languages and certify to best of my knowledge and belief that the attached is a true and correct English translation of the priority document of Japanese patent application 2003-010626 filed on January 20, 2003.

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[TITLE OF INVENTION] VEHICLE HEADLAMP UNIT

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[Title of Invention] VEHICLE HEADLAMP UNIT

[Claims]

[Claim 1] A vehicle headlamp unit comprising luminous distribution control means for controlling a direction or a range of illumination by light from a light source, and an actuator for driving said luminous distribution control means; characterized in that: said actuator includes a resin-molded casing in which component parts, including a gear mechanism and a board, are contained; and a step-like rib for supporting said component parts is formed at an inner side of a peripheral edge portion of said casing to increase a thickness of said peripheral edge portion, and an opposed rib is formed at an outer side of said peripheral edge portion, and extends along a generally channel-shaped groove recessed toward said step-like rib.

[Claim 2] A vehicle headlamp unit according to claim 1, characterized in that at least part of a plurality of gears, forming said gear mechanism, is made of a resin having self-lubricating properties.

[Detailed Description of the Invention]

[0001]

[Technical Field]

[0001]

This invention relates to a headlamp unit for a vehicle

such as an automobile, and more particularly to the structure of an actuator for deflecting an optical axis of a headlamp used in a headlamp unit provided with luminous distribution control means (for example, an adaptive front-lighting system (hereinafter referred to as "AFS")) for changing the direction and range of illumination by the headlamp in accordance with a running condition.

[0002]

In an AFS which has been proposed in order to enhance a running safety of an automobile, information representative of a running condition of an automobile CAR is detected by sensors 1, and detection outputs of these sensors are sent to an electronic control unit (hereinafter referred to as "ECU") 2 as shown in Fig. 1 which is a conceptual view. For example, as the sensors 1, there are provided a steering sensor 1A for detecting a steering angle of a steering wheel SW of the automobile CAR, a speed sensor 1B for detecting the speed of the automobile CAR, and leveling sensors 1C (only the sensor for a rear axle is shown) for respectively detecting the heights (or levels) of the front and rear axles so as to detect a horizontal condition (leveling) of the automobile CAR. These sensors 1A, 1B and 1C are connected to the ECU 2. In accordance with the outputs of the sensors 1 inputted thereto, the ECU 2 controls swivel lamps 3R and 3L (that is, headlamps 3 each capable of deflecting an illuminating direction right and left

to change its luminous distribution characteristics) provided respectively at right and left portions of the front of the automobile. In one known example of such swivel lamp 3R, 3L, a reflector and a projector lamp are provided within the headlamp, and can be angularly moved in a horizontal direction, and these are driven for rotation by a drive power source (such as a drive motor) through rotation drive means. Here, a mechanism, including this rotation drive source, is referred to as an actuator. When a car travels along a curved road, this kind of AFS enables the headlamps to illuminate a road ahead of the curve in accordance with the running speed of the car, and therefore the AFS is effective in enhancing the running safety.

[0003]

There has been proposed one example of such actuator in which a drive motor, serving as a drive power source, and a gear mechanism, serving as rotation drive means, are mounted within a casing. It has also been proposed to provide circuit means (for controlling the rotation of the drive motor) within the above casing. In such an actuator, in order to achieve a lightweight design and low-cost design of the casing so as to enhance the ability of mounting the casing within the lamp and also in order to enhance the reliability of the operation of the gear mechanism mounted within the casing, a glass fiber-containing PBT resin, which has high flexural rigidity

and good heat resistance, and is relatively inexpensive, is used as a material for forming the casing. Although a plurality of gears, forming the gear mechanism mounted within the casing, are usually made of a metal material, it has been proposed to form these gears by a resin material also in order to achieve the lightweight design and low-cost design of the actuator, and in this case, a thermosetting resin, such as a phenolic resin which can be highly precisely molded into a predetermined shape, or a resin such as a polyacetal resin, is used. Grease is coated on the gears to provide lubricity between the adjacent gears.

[0004]

[Subject to be resolved by the invention]

In the above conventional actuator for the AFS, it has been proposed to form the casing and the gears of the gear mechanism, using a resin. However, when the casing is molded of a glass fiber-containing PBT resin suited for this use, warp is liable to develop in this resin-molded casing, and therefore the distance between axes of adjacent gears of the contained gear mechanism varies, which invites problems such as the inaccurate meshing of the gear train, the production of abnormal sounds and the development of a slip between the meshed gears, thus preventing the proper operation of the gear mechanism. In order to prevent such warp of the casing, it may be proposed to form a rib (counter-rib) integrally on and along a peripheral edge portion of the casing, the rib projecting from an outer

surface of the casing in a direction away from its adjacent bent portion. However, the counter-rib projects several millimeters from the outer surface of the casing, and therefore the outer size of the casing is increased by this rib, and this invites a problem that the size of the actuator is increased, so that the ability of mounting the actuator within the lamp is lowered.

[0005]

Wear resistance of the meshed gears is secured by the grease applied to the gears to provide lubricity therebetween. However, when the actuator, mounted within the lamp, is heated by heat of the lamp, so that its temperature rises, the grease evaporates, and is dissipated to the exterior of the casing, and the dissipated grease deposits on a surface of lens of the lamp, and is solidified to fog the lens, thus inviting a so-called grease-fogging problem. Particularly in recent lamps, there has been extensively used a transparent lens (outer cover), and therefore the fogging by the grease is a cause for deteriorating the quality of the lamp.

[0006]

It is an object of this invention to provide a vehicle headlamp unit in which the above various problems, encountered when the parts of the actuator are made of a resin, are solved.

[0007]

[Means for resolving the object]

According to the present invention, there is provided a vehicle headlamp unit comprising luminous distribution control means for controlling a direction or a range of illumination by light from a light source, and an actuator for driving the luminous distribution control means; characterized in that: the actuator includes a resin-molded casing in which component parts, including a gear mechanism and a board, are contained; and a step-like rib for supporting the component parts is formed at an inner side of a peripheral edge portion of the casing to increase a thickness of the peripheral edge portion, and an opposed rib is formed at an outer side of the peripheral edge portion, and extends along a generally channel-shaped groove recessed toward the step-like rib. In the invention, preferably, at least part of a plurality of gears, forming the gear mechanism, is made of a resin having self-lubricating properties.

[0008]

In the invention, the casing of the actuator is molded of a resin, and therefore the lightweight design and low-cost design can be achieved. The step-like rib is formed at the inner surface of the casing, and the channel-shaped groove is formed in the outer surface of the casing to provide the opposed rib. Therefore, in the resin-molding of the casing, an uneven flow of the resin in a region for forming the peripheral edge portion is prevented, and as a result warp of the casing is suppressed.

The step-like rib supports the component part, and the opposed rib does not project beyond the outer surface of the casing. Therefore, there is no need to provide an additional support member for supporting this component part, and the board can be fixedly supported directly by the casing, and therefore the outer size of the casing will not increase with the provision of a counter-rib, and therefore the casing can be formed into a compact design. The gear of the gear mechanism is made of the self-lubricating resin, and therefore the gear mechanism does not need to be provided with grease, and the fogging of the lamp due to grease is prevented.

[0009]

[Mode for carrying out the invention]

A preferred embodiment of the present invention will now be described with reference to the drawings. Fig. 2 is a vertical cross-sectional view of a headlamp 3 (comprising a swivel lamp 3R, 3L capable of deflecting an illuminating direction right and left, the swivel lamp being a constituent element of an AFS serving as lamp deflection angle control means of the invention), showing an internal structure thereof, and Fig. 3 is a partly-exploded, perspective view of a main portion thereof. A lens 12 is attached to a front open portion of a lamp body 11, and a rear cover 13 is attached to a rear open portion thereof, thereby forming a lamp chamber 14. A projector lamp 30 is provided within the lamp chamber 14. The projector

lamp 30 comprise a sleeve 301, a reflector 302, a lens 303, and a light source 304 which are combined together into a unit. This kind of projector lamp has already been extensively used, and therefore detailed description thereof will be omitted here. A discharge bulb is used as the light source 304. The projector lamp 30 is supported by a generally U-shaped bracket 31. An extension 15 is provided around the projector lamp 30 in the lamp body 11 to prevent the interior of the lamp from being viewed through the lens 12. In this embodiment, a lighting circuit 7 for lighting the discharge bulb 304 of the projector lamp 30 is mounted in the lamp by the use of a lower cover 16 attached to a lower open portion of the lamp body 11.

[0010]

The projector lamp 30 is supported by the bracket 31 in such a manner that this projector lamp is interposed between a lower plate 312 and an upper plate 313 which extend substantially perpendicularly from a vertical plate 311 of the bracket 31. An actuator 4 (described later) is fixedly secured to a lower side of the lower plate 312 by screws 314, and a rotation output shaft 448 of the actuator 4 projects upwardly through a shaft hole 315 formed through the lower plate 312. The screws 314 are screw-fastened respectively to bosses 318 formed on the lower surface of the lower plate 312. A shaft portion 305, formed on an upper surface of the projector lamp 30, is fitted in a bearing 316 provided on the upper plate 313,

and a connecting portion 306, provided on a lower surface of the projector lamp 30, is fitted on the rotation output shaft 448 of the actuator 4, and is connected thereto. With this construction, the projector lamp 30 can be angularly moved right and left relative to the bracket 31, and when the actuator 4 is operated, the projector lamp 30 is angularly moved in a horizontal direction together with the rotation output shaft 448.

[0011]

Aiming nuts 321 and 322 are fixedly mounted respectively on upper left and right portions of the bracket 31 (as viewed from the front side), while a leveling bearing 323 is fixedly mounted on a lower left portion of the bracket. A horizontal aiming screw 331 and a vertical aiming screw 332, which are threadably supported on the lamp body 11, are threaded into the aiming nuts 321 and 322, respectively. A leveling ball 51 of a leveling mechanism 5, supported on the lamp body 11, is fitted in the leveling bearing 323. With this construction, by threading the horizontal aiming screw 331, the bracket 31 can be angularly moved in the horizontal direction about an axis passing through the right aiming nut 322 and the leveling bearing 323. By threading the horizontal aiming screw 331 and the vertical aiming screw 332 at the same time, the bracket 31 can be angularly moved upward and downward about the leveling bearing 323. When the leveling mechanism 5 is operated, the

leveling ball 51 is moved forward and backward in an axial direction, and by doing so, the bracket 31 can be angularly moved upward and downward about an axis passing through the left and right aiming nuts 321 and 322. With this construction, the aiming adjustments for adjusting the optical axis of the projector lamp 30 in the left and right directions and the upward and downward directions can be effected, and also there can be effected the leveling adjustment for adjusting the optical axis of the projector lamp in the upward and downward directions in accordance with a leveling condition changing with a change of a car height. A projection 307 is formed on a lower surface of the reflector 302 of the projector lamp 30, and a pair of stamped-out stoppers 317 are formed respectively at left and right sections of that portion of the lower plate 312 (of the bracket 31) generally opposed to the projection 307. When the projector lamp 30 is angularly moved, the projection 307 is brought into engagement with one of the stoppers 317, thereby limiting the range of angular movement of the projector lamp 30.

[0012]

Fig. 4 is an exploded, perspective view of a main portion of the actuator 4 for swiveling the swivel lamp 3R, 3L, and Fig. 5 is a plan view showing the construction of the actuator in its assembled condition, and Fig. 6 is a vertical cross-sectional view thereof. A casing 41 is formed by a lower

half portion 41D and an upper half portion 41U each having a generally-pentagonal dish-like shape, and each of the two half portions 41D and 41U is molded of a glass fiber-containing PBT resin. A plurality of projections 410, formed on a peripheral surface of the lower half portion 41D, are fitted respectively in a plurality of fitting piece portions 411 extending downwardly from a peripheral surface of the upper half portion 41U. Therefore, the upper half portion 41U is placed on the lower half portion 41D, and then when the upper half portion 41U is pressed toward the lower half portion 41D, the fitting piece portions 411 are fitted on the projections 410, respectively, so that the two half portions are firmly combined together to form a casing chamber therein as shown in Figs. 7(a) and (b) (which are perspective views of the assembled casing 41, showing its appearance respectively from the upper side and the lower side), and at the same time the assembling of the casing 41 can be easily effected with a one-touch operation.

[0013]

As shown in Fig. 8 which is a side-elevational view of the casing 41 in its assembled condition, support piece portions 413 are formed on and project from opposite side surfaces of the upper half portion 41U, respectively, while support piece portions 412 are formed on and project from opposite side surfaces of the lower half portion 41D, respectively. These support piece portions 412 and 413 are used to fix the casing

41 to the bracket 31 through the screws 314 as described above. Thus, each mating pair of support piece portions 412 and 413 are combined together, and are fixed to the boss 318, and therefore the fitted condition of each fitting piece portion 411 relative to the corresponding projection 410 is maintained, so that the overall strength of the casing 41 increases. The rotation output shaft 448, having splines, projects from the upper surface of the pentagonal casing 41 at one end portion thereof corresponding to an apex side of the pentagonal shape, and is connected to the connecting portion 306 provided at the bottom surface of the projector lamp 30. A connector 451 is provided at an inner side of the other end of the casing 41 corresponding to a bottom side of the pentagonal shape. An external connector 21 (see Figs. 2 and 3), connected to an ECU2, is adapted to be fittingly connected to this connector 451. With this construction, when the casing 41 is fixed to the bracket 31 through the support piece portions 412 and 413, the casing 41 is fixed to the bracket 31 at a region disposed generally at a middle point of a line interconnecting the rotation output shaft 448 and the connector 451. Therefore, even when a rotational drive force is applied to the rotation output shaft 448 and when a fitting force for fitting the external connector 21 to the connector 45 is applied to the connector 45, the casing 41 can keep a stable posture, and particularly the smooth and accurate angular movement of the

projector lamp 30 by the rotation output shaft 448 can be achieved.

[0014]

Four hollow bosses 414, 415, 416 and 417 are formed upright respectively on predetermined portions of an inner bottom surface of the lower half portion 41D of the casing 41. A brushless motor 42 (described later), serving as a drive motor, is assembled on the first hollow boss 414. Shafts of a gear mechanism 44 (described later) are inserted and supported in the second to fourth hollow shafts 415, 416 and 417, respectively. A step-like rib 418 is formed integrally on a peripheral edge portion of the inner bottom surface of the lower half portion 41D over an entire periphery thereof, and a printed circuit board 45 is placed at its peripheral edge portion on the step-like rib 418, and the printed circuit board 45 is mounted and supported within the casing 41 in such a manner that this printed circuit board 45 is held between the step-like rib 418 and a downwardly-directed rib (not shown) formed on the upper half portion 41U. The first hollow boss 414 passes through the printed circuit board 45, and the assembled brushless motor 42 is electrically connected to the printed circuit board 45, and various electronic parts (not shown) of a control circuit 43 (described later) and the connector 451 are mounted on the printed circuit board 45.

[0015]

As shown in Fig. 6 and Fig. 9 (which is a fragmentary perspective view of the casing 41), the peripheral edge portion 41a of the lower half portion 41 has an increased thickness as a result of the provision of the step-like rib 418. A narrow channel-shaped groove 41b is formed in the bottom surface of the peripheral edge portion 41a, and extends along the step-like rib 418. As a result of the formation of the channel-shaped groove 41b, an opposed rib 41, opposed to the step-like rib 418, is formed at a region disposed outwardly of the channel-shaped groove 41b. The thickness of the opposed rib 419 is substantially equal to a wall thickness of the lower half portion 41D. In this embodiment, that portion of the channel-shaped groove 41b, disposed at the region where the step-like rib 418 supports the printed circuit board 45, is relatively deep, while the other portion of the channel-shaped rib 41b, disposed at a region R in Fig. 7(b) where the step-like rib 418 does not support the printed circuit board 45, is shallower. Thus, the thickened condition of the peripheral edge portion 41a is relieved by the channel-shaped groove 41b, and the opposed rib 419 is formed by part of the groove portion. With this construction, when the lower half portion 41D is to be resin-molded by a mold, an uneven flow of the resin in a region for forming the peripheral edge portion 41a is prevented, and as a result warp at the peripheral edge portion 41a of the lower half portion 41D is suppressed. The opposed rib 419, formed

as a result of the formation of the channel-shaped groove 41b, has such a height that its outer edge is disposed substantially flush with the bottom surface of the lower half portion 41D. Therefore, the opposed rib 491 does not project beyond the outer surface of the lower half portion 41D in contrast with the above-mentioned counter-rib, and the outer size of the lower half portion 41D will not increase, and the lower half 41D and hence the casing 41 can be formed into a compact design. Incidentally without the channel-shaped groove 41b, a flow of the resin concentrates on the thickened peripheral edge portion 41a of the lower half portion 41D during the resin-molding operation, so that the flow of the resin becomes uneven, and after the molding, warp is liable to develop at the lower half portion 41D, and also sinks are liable to develop in the surface thereof.

[0016]

In the brushless motor 42, a rotation shaft 423 is rotatably supported in the first hollow boss 414 of the lower half portion 41D through a thrust bearing 421 and a sleeve bearing 422. A stator coil 424, including three pairs of coils equally spaced in a circumferential direction, is fixedly mounted on the printed circuit board 45 which is supported on the lower half portion 41D, with the first hollow boss 414 passing therethrough. The stator coil 424 is electrically connected to the printed circuit board 45 so as to be supplied

with electric power. Here, the stator coil 424 is integrally combined with a core base 425, and is electrically connected to the printed circuit board 45 via terminals 425a formed at the core base 425. A cylindrical container-like rotor 426 is fixedly mounted on an upper end portion of the rotation shaft 423 in surrounding relation to the stator coil 424. The rotor 426 comprises a resin-molded yoke 427 of a cylindrical container-shape, and an annular rotor magnet 428 which is mounted on an inner surface of the yoke 427, and has S-poles and N-poles alternately magnetized therein in a circumferential direction.

([0017])

In the brushless motor 42 of this construction, by supplying AC powers U, V and W, different in phase, to the three coils of the stator coil 424, the direction of a magnetic force between the stator coil and the rotor magnet 428 is changed, thereby driving or rotating the rotor 426 and the rotation shaft 423. As shown in Figs. 10, a plurality of (three in this embodiment) Hall elements or Hall ICs (hereinafter referred to as "Hall ICs") H1, H2 and H3 are mounted on the printed circuit board 45, and are arranged at predetermined intervals in the direction of the circumference of the rotor 426. When the rotor magnet 428 rotates together with the rotor 426, a magnetic field at each of the Hall ICs H1, H2 and H3 is changed, and each Hall IC H1, H2, H3 is changed between an ON-state and an OFF-state,

and outputs a pulse signal corresponding to a rotation period of the rotor 426.

[0018]

In Figs. 4 to 6, the first gear 441, resin-molded integrally with the yoke 427 of the rotor 426, forms part of the gear mechanism 44, and is designed to drive and rotate the rotation output shaft 448 in a speed-reducing manner. Namely, the gear mechanism 44 includes the first gear 441, a second gear 443 rotatably mounted on a first fixed shaft 442 supported in the second hollow boss 415, a third gear 445 rotatably mounted on a second fixed shaft 444 supported in the third hollow boss 416, and a sector gear 447 which is rotatably supported on a third fixed shaft 446 supported in the fourth hollow boss 417, and is formed integrally with the rotation output shaft 448. Each of these gears is molded of a resin. As shown in Figs. 5 and 6, the second gear 443 includes a second larger-diameter gear 443a and a second smaller-diameter gear 443b which are integrally formed with each other, and are arranged in an axial direction, the second larger-diameter gear 443a being in mesh with the first gear 441. The third gear 445 includes a third larger-diameter gear 445a and a third smaller-diameter gear 445b which are integrally formed with each other, and are arranged in an axial direction, the third larger-diameter gear 445a being in mesh with the second smaller-diameter gear 443b. The third smaller-diameter gear 445b is in mesh with the sector

gear 447. The axial positions of these meshed gears are determined such that the meshing of these gears is made sequentially in the axial direction of each shaft from the first gear 411 of the first stage toward the sector gear 447 of the final stage, that is, in the downward direction when the lower half portion 41D is defined as a reference. Therefore, when these gears are to be mounted within the casing 41, with the respective shafts passed therethrough, the gears need only to be sequentially incorporated into the casing, so that the operation for assembling the actuator can be carried out easily.

[0019]

With this construction of the gear mechanism 44, a rotational force of the first gear 441, rotating together with the rotor 427 of the brushless motor 42, is reduced through the second gear 443, the third gear 445 and the sector gear 447, and is transmitted to the rotation output shaft 448. Stoppers 419 are formed on and project from the inner surface of the lower half portion 41D, and are disposed respectively at opposite ends of a path of rotation of the sector gear 447, and opposite ends of the sector gear 447 can be brought into abutting engagement with the stoppers 491, respectively. These stoppers 419 limit the range of angular movement of the sector gear 447 and hence the range of angular movement of the rotation output shaft 448.

[0020]

The first, second and third gears 441, 443 and 445 and

the sector gear 447 are made of a resin, and here the following materials are used for these gears.

(a) First gear 441 (integral with the yoke 427): Phenolic resin

(b) Second gear 443: Polyacetal containing sliding agent

(c) Third gear 445: Standard polyacetal

(d) Sector gear 447 (integral with the rotation output shaft 448): Nylon

[0021]

The first gear 441 is made of a phenolic resin (thermosetting resin) which can be highly precisely molded into a predetermined shape. By doing so, the first gear 441, having the smallest diameter, can be formed with high dimensional accuracy, and the rotational drive force, produced by the brushless motor 42, can be transmitted to the gear mechanism at a high gear ratio, that is, at a high reduction ratio. The second gear 443 is made of polyacetal containing the sliding agent having self-lubricating properties, and by doing so, the lubricity in the meshing engagement of this second gear with the first and third gears 441 and 445 is enhanced. The sector gear 447, which is integral with the rotation output shaft 448 for directly angularly moving the projector lamp 30, is made of nylon having high heat resistance, and by doing so, the smoothness in the meshing engagement of this sector gear with

the third gear 445 is enhanced, and besides thermal deformation due to heat, developing during the angular movement, is prevented, so that the rotation drive force can be properly transmitted to the projector lamp 30. Therefore, it is not necessary to use grease in the meshed gears of the gear mechanism 44, and the fogging of the lamp lens and others by grease can be prevented.

[0022]

The above resin materials for the first to third gears and sector gear are given merely as one example, and a self-lubricating resin, a heat-resistant resin, a resin capable of achieving high dimensional accuracy can be suitably used in combination, and by doing so, similarly, there can be provided the gear mechanism which has high lubricating properties and a high reliability of the operation.

[0023]

Fig. 11 is a block diagram of the electric circuit of the lighting unit including the ECU 2 and the actuator 4. The actuator 4 is provided in each of the right and left swivel lamps 3R and 3L of the car, and a two-way communication can be effected between the actuator 4 and the ECU2. The ECU 2 includes a main CUP 201 for effecting a processing on the basis of information from the sensors 1 according to a predetermined algorithm to output a required control signal C0, and an interface (hereinafter referred to as "I/F") circuit 202 for inputting

and outputting the control signal CO between the main CPU 201 and the actuator 4. An ON/OFF signal from a lighting switch S1, provided at the car, can be inputted into the ECU 2, and in accordance with the ON/OFF state of the lighting switch S1, the ECU 2 controls the lighting circuit 7 (connected to an on-vehicle power source (not shown) so as to supply electric power to the discharge bulb 304 of the projector lamp 30) by a control signal N so as to turn on and off the swivel lamp 3R, 3L. The ECU 2 controls a leveling control circuit 6 (for controlling the leveling mechanism 5 for adjusting the optical axis of the bracket (supporting the projector lamp 30) in the upward-downward direction) by a leveling signal DK so as to adjust the optical axis of the projector lamp 30 in accordance with a change of the car height. Naturally, the condition of connection of these electric circuits to the power source is turned on and off by an ignition switch S2 for turning on and off an electric system provided at the car.

[0024]

The control circuit 43, provided on the printed circuit board 45 contained in the actuator 4 mounted in each of the right and left swivel lamps 3R and 3L of the car, includes an I/F circuit 432 for inputting and outputting a signal between the control circuit 43 and the ECU 2, a sub-CPU 431 for effecting a processing on the basis of a signal from the I/F circuit 432 and pulse signals from the Hall ICs H1, H2 and H3 according to

a predetermined algorithm, and a motor drive circuit (rotation drive means) 434 for driving and rotating the brushless motor 42. The ECU 2 outputs a right-left deflection angle signal DS (which is part of the control signal CO) representative of a right-left deflection angle of the swivel lamp 3R, 3L, and this signal is inputted to the actuator 4.

[0025]

Fig. 12 is a circuit diagram schematically showing the motor drive circuit 434 of the control circuit 43 and the brushless motor 42 in the actuator 4. The motor drive circuit 434 includes a switching matrix circuit 435, and an output circuit 436. As control signals, a speed control signal V, a start/stop signal S and a normal/reverse rotation signal R from the sub-CPU 431 of the control circuit 43, as well as pulse signals from the three Hall ICs H1, H2 and H3, are inputted into the switching matrix circuit 435. The output circuit 436 is responsive to an output of the switching matrix circuit 435 to adjust the phases of three-phase (U-phase, V-phase and W-phase) electric powers which are to be supplied respectively to the three pairs of coils of the stator coil 424 of the brushless motor 42. In this motor drive circuit 434, the U-phase, V-phase and W-phase powers are supplied to the stator coil 424, thereby rotating the rotor magnet 428, and therefore the yoke 427 (integral with this rotor magnet), that is, the rotor 426 and the rotation shaft 423, rotate. When the magnet rotor 428

rotates, the Hall ICs H1, H2 and H3 detect a change of the magnetic field to output pulse signals P, respectively, and these pulse signals P are inputted into the switching matrix circuit 435, and in this switching matrix circuit 435, a switching operation for the output circuit 436 is effected in accordance with the timings of the pulse signals, so that the rotor 426 continues to rotate.

[0026]

In accordance with the speed control signal V, the start/stop signal S and the normal/reverse rotation signal R from the sub-CPU 431, the switching matrix circuit 435 feeds a required control signal C1 to the output circuit 436. In response to this control signal C1, the output circuit 436 adjusts the phases of the three-phase powers (which are to be supplied to the stator coil 424), and controls the start and stop of the rotation of the brushless motor 42, the direction of rotation thereof and the speed of rotation thereof. Part of each of the pulse signals P, outputted respectively from the Hall ICs H1, H2 and H3, is inputted into the sub-CPU 431, so that this sub-CPU recognizes the rotating condition of the brushless motor 42. An up-down counter 437 is contained in the sub-CUP 431, and the pulse signals from the Hall ICs H1, H2 and H3 are counted, so that the value of this count corresponds to the rotational position of the brushless motor 42.

[0027]

In the above construction, when the ignition switch S2 is turned on, and also the lighting switch S1 is turned on, information, representing the steering angle of the steering wheel SW, the speed of the car, the car height of the car, etc., is inputted into the ECU 2 from the sensors 1 mounted on the car as shown in Fig. 1. In the ECU 2, the main CPU 201 effects a computing operation on the basis of the sensor outputs inputted thereto, and computes the right-left deflection angle signal DS of the projector lamp 30 of each of the swivel lamps 3R and 3L of the car, and these signals DS are inputted respectively to the actuators 4 of the two swivel lamps 3R and 3L. In the actuator 4, the sub-CPU 431 effects a computing operation on the basis of the right-left deflection angle signal DS inputted thereto, and computes a signal corresponding to this right-left deflection angle signal DS, and this computed signal is fed to the motor drive circuit 434, thereby driving and rotating the brushless motor 42. A rotation drive force of the brushless motor 42 is reduced in speed by the reduction gear mechanism 44, and is transmitted to the rotation output shaft 448. Therefore, the projector lamp 30, connected to the rotation output shaft 448, is angularly moved in the horizontal direction, so that the optical axis of the swivel lamp 3R, 3L is deflected right and left. When the projector lamp 30 is thus angularly moved, the angle of deflection of the projector lamp 30 is detected by the angle of rotation of the brushless motor

42. Namely, the sub-CPU 431 detects this deflection angle on the basis of the pulse signals P (P1, P2 and P3) outputted from the three Hall ICs H1, H2 and H3 provided at the brushless motor 42 as shown in Fig. 10. Further, the sub-CPU 431 compares the right-left deflection angle signal DS, inputted thereto from the ECU2, with a detection signal representative of the detected deflection angle, and effects a feedback control of the rotation angle of the brushless motor 42 so that the two can coincide with each other, and by doing so, the optical axis of the projector lamp 30, that is, the optical axis of the swivel lamp 3R, 3L, can be highly precisely brought into a deflection position set by the right-left detection angle signal DS.

[0028]

In this deflecting operation for the projector lamp 30, deflected light, emitted from the swivel lamp 3R, 3L, illuminates a zone deflected right or left from a direction of straight travel of the car, and therefore during the travel of the car, each lamp can illuminate a zone ahead of the car not only in the direction of straight travel of the car but also in a direction toward which the car is steered, and therefore the driving safety can be enhanced.

[0029]

In the above embodiments, although the projector lamp is angularly moved by the actuator of the invention, the invention can, of course, be applied to the type of AFS in which a reflector

is angularly moved so as to deflect an optical axis of illumination of a lamp. Also, the invention can be applied to the type of AFS in which part of a swivel lamp is angularly moved in a controlled manner so as to control the range of illumination of the lamp.

[0030]

[Advantage of the invention]

As described above, in the present invention, the casing of the actuator is molded of the resin, and therefore the lightweight design and low-cost design can be achieved. The channel-shaped groove is formed in the outer surface of the thickened peripheral edge portion of the casing having the step-like rib formed at the inner surface thereof, so that the opposed rib is formed. Therefore, in the resin-molding of the casing, an uneven flow of the resin in the region for forming the peripheral edge portion is prevented, and as a result warp is prevented from developing at the peripheral edge portion of the casing. Thanks to the provision of the step-like rib, there is no need to provide an additional support member for supporting the component part, and the board can be fixedly supported directly by the casing. The opposed rib does not project beyond the outer surface of the casing, therefore the outer size of the casing is prevented from increasing, and the casing can be formed into a compact design. The gear of the gear mechanism is made of the self-lubricating resin, and

therefore the gear mechanism does not need to be provided with grease, and the fogging of the lamp due to grease is prevented. Thus, the lightweight design, compact design and low-cost design of the actuator can be achieved, and the assembling efficiency can be enhanced.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1 is a view showing a conceptual construction of an AFS.

[Fig. 2]

Fig. 2 is a vertical cross-sectional view of a swivel lamp.

[Fig. 3]

Fig. 3 is an exploded, perspective view showing an internal structure of the swivel lamp.

[Fig. 4]

Fig. 4 is a partly-exploded, perspective view of an actuator.

[Fig. 5]

Fig. 5 is a plan view of the actuator.

[Fig. 6]

Fig. 6 is a vertical cross-sectional view of the actuator.

[Fig. 7]

Fig. 7 are perspective views of a casing, showing its appearance respectively from the upper side and the lower side.

[Fig. 8]

Fig. 8 is a side-elevational view of the casing.

[Fig. 9]

Fig. 9 is a fragmentary perspective view showing a portion of the casing.

[Fig. 10]

Fig. 10 is an exploded, perspective view of the brushless motor.

[Fig. 11]

Fig. 11 is a block circuit diagram showing a circuit construction of the AFS.

[Fig. 12]

Fig. 12 is a circuit diagram showing a circuit construction of the actuator.

[Description of Reference Numeral]

1 a sensor

2 an ECU

3 a headlamp

3L and 3R swivel lamps

4 an actuator

5 a leveling mechanism

7 a lighting circuit

41 a casing

41U an upper half

41D a lower half

42 a brushless motor

44 a gear mechanism

45 a printed circuit board

410 a projection

411 fitting piece portion

412, 413 support piece portions

418 a step-like rib

419 an opposed rib

441 a first gear

443 a second gear

445 a third gear

447 a sector gear

H1 H2 and H3 Hall ICs

S1 an ignition switch

S2 a lighting switch.

[Designation of Document] Abstract

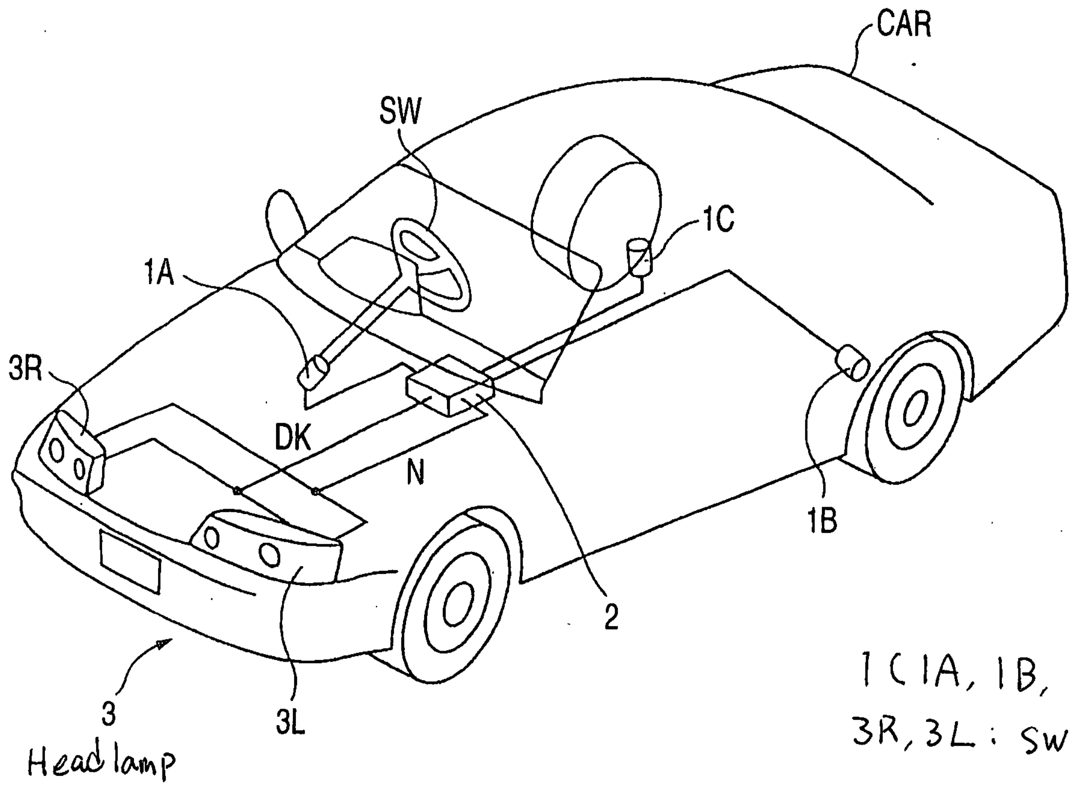
[Abstract]

[Problem] To provide a vehicle headlamp unit in which problems, of large sizing of a case and a fogging by a grease that are occurred when an actuator consisting a rotational driving mechanism for swinging the lamp is made of resin, are resolved.

[Means for Resolution] An actuator for deflecting a direction or a range of illumination by light from a light source includes a resin-molded casing 41 in which component parts, including a gear mechanism 44 and a printed circuit board 45, are contained, and a step-like rib 418 for supporting the printed circuit board 45 is formed at an inner side of a peripheral edge portion 41a of the casing 41, and an opposed rib 419 is formed at an outer side of this peripheral edge portion by a generally channel-shaped groove 41b. By the opposed rib 419, warp is prevented from developing in the casing 41, the outer size of the casing is prevented from increasing, and the casing can be formed into a compact design. A gear in the gear mechanism 44 is made of a resin having self-lubricating properties, as a result, the gear mechanism does not need to be provided with grease, and the fogging of the lamp due to grease is prevented.

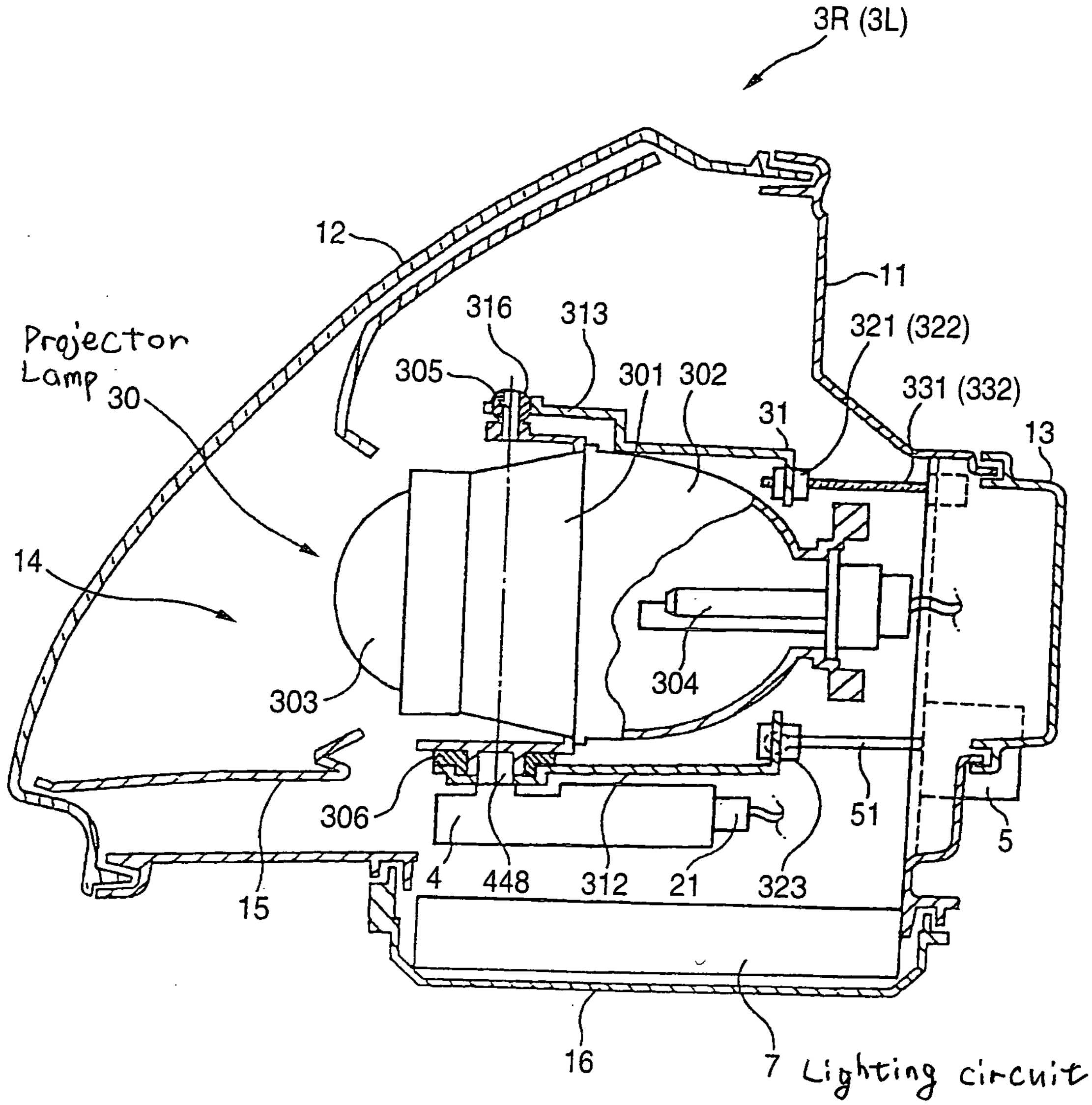
2003-010626

FIG. 1



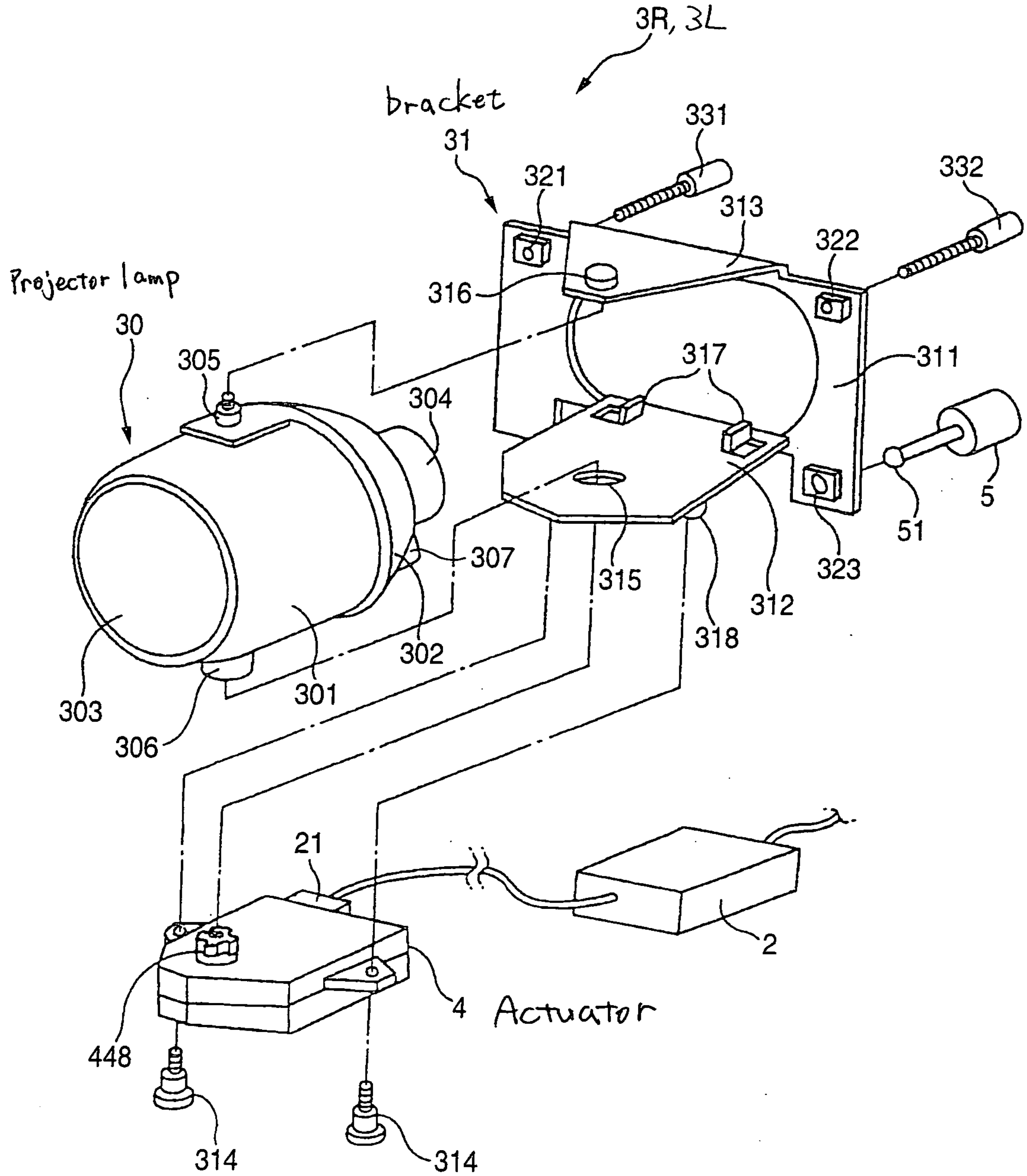
1 (1A, 1B, 1C) : sensor
3R, 3L : swivel lamp

FIG. 2



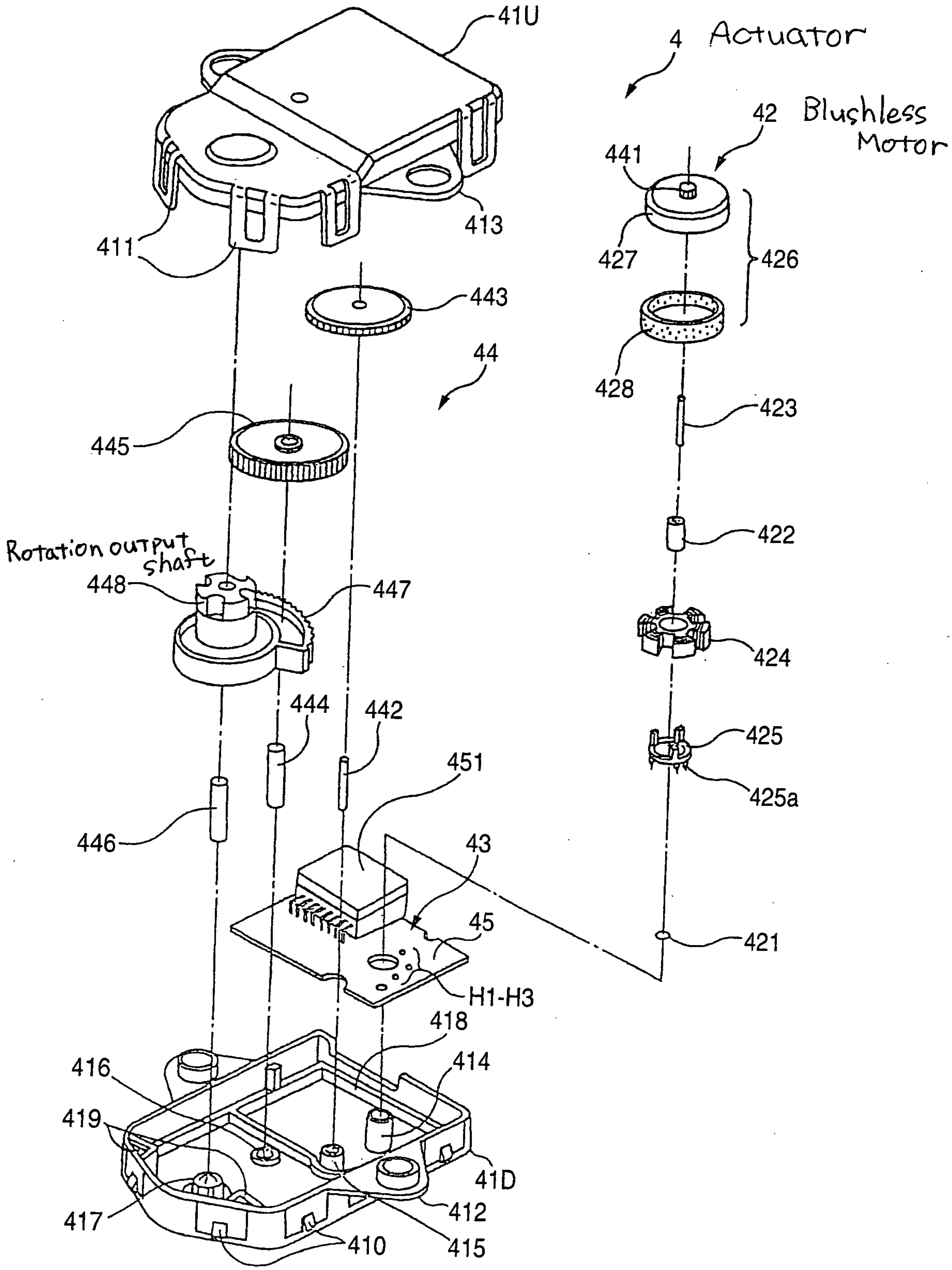
3R (3L)
12
11
Projector Lamp 30
316
313
305
301
302
31
321 (322)
331 (332)
13
14
304
303
306
448
4
312
21
323
51
5
15
16
7 Lighting circuit

FIG. 3



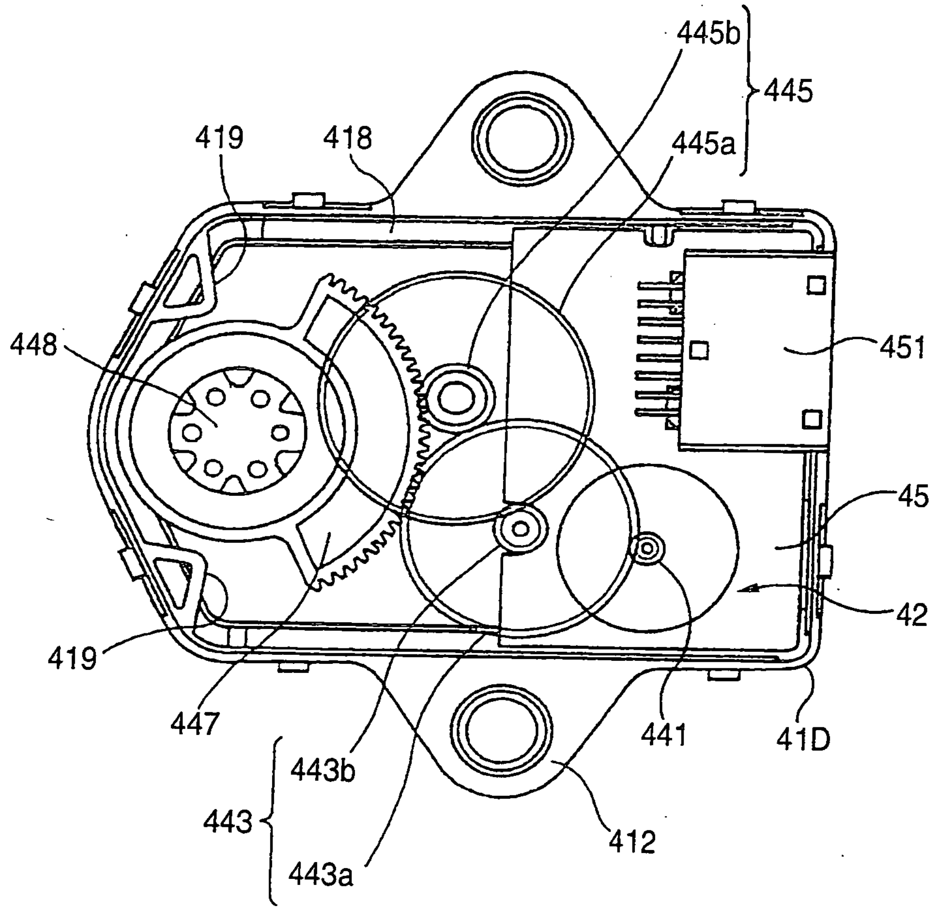
3R, 3L
bracket
31
331
321
313
332
322
Projector lamp
316
30
317
305
311
304
5
51
307
315
323
312
318
302
303
301
306
21
2
4 Actuator
448
314
314

FIG. 4



41U
4 Actuator
42 Blushless Motor
441
427
426
428
423
422
424
425
425a
421
411
413
443
44
445
Rotation output shaft
448
447
444
442
446
451
43
45
H1-H3
418
416
414
419
41D
412
417
410
415

FIG. 5



445b
445
445a
419
418
448
451
45
42
419
447
441
41D
443b
443
443a
412

FIG. 6

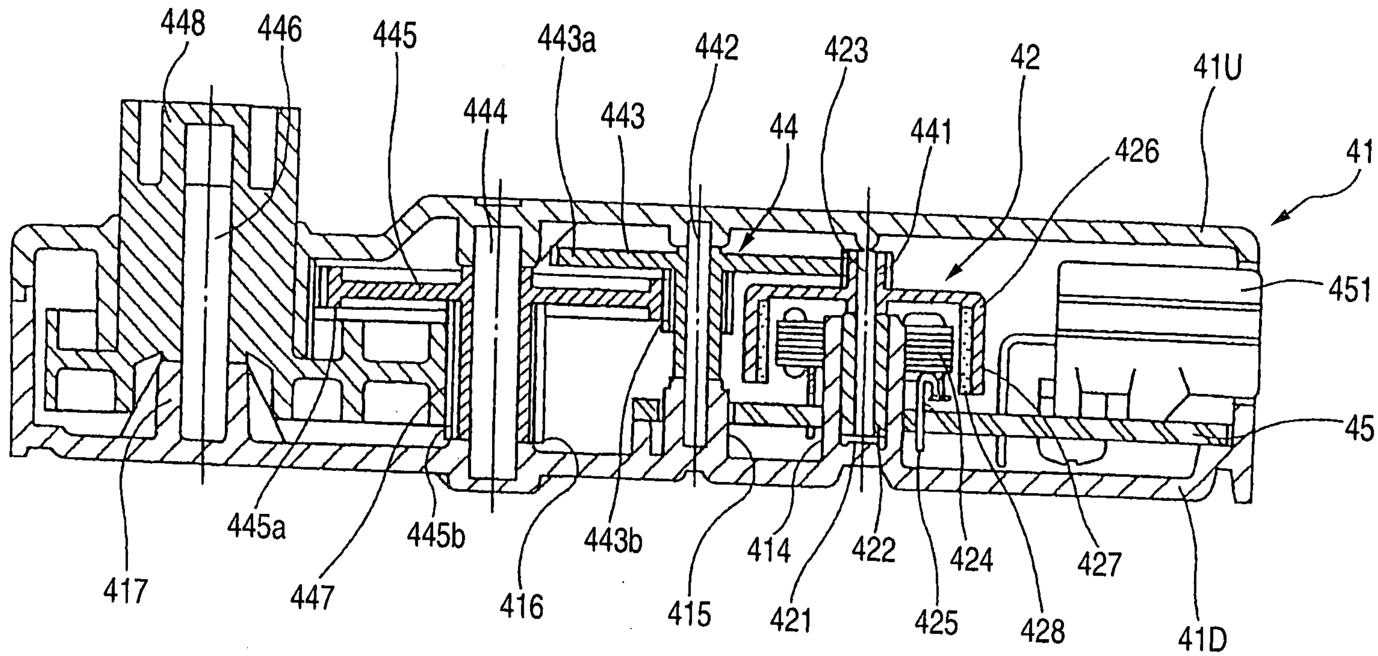

448
446
445
443a
444
443
442
423
44
441
42
426
41U
41
451
45
417
445a
447
445b
416
443b
415
414
421
422
425
424
428
427
41D

FIG.7

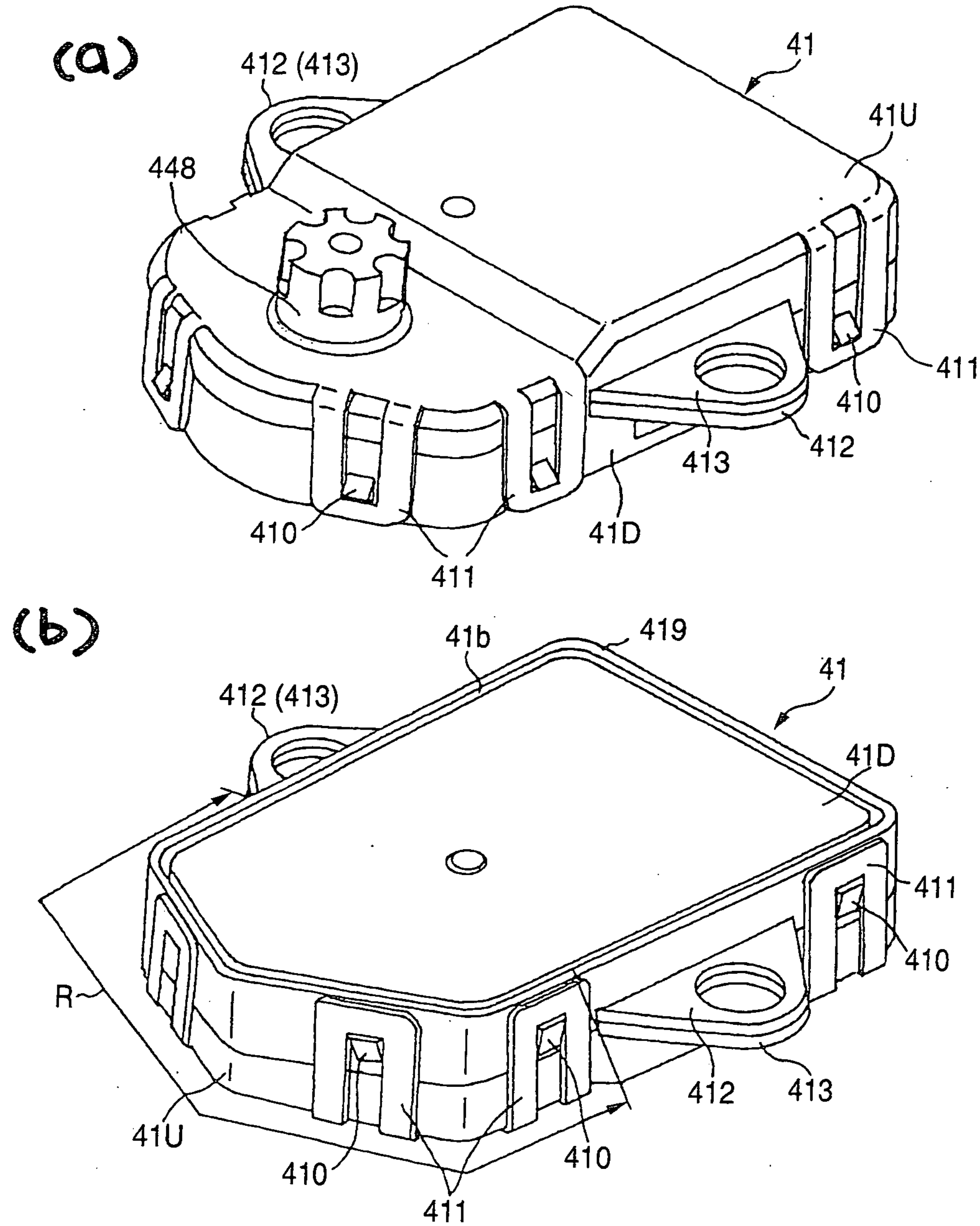

(a)
412 (413)
41
41U
448
411
410
412
413
410
41D
411
(b)
41b
419
41
412 (413)
41D
411
410
R
412
413
41U
410
410
411

FIG. 8

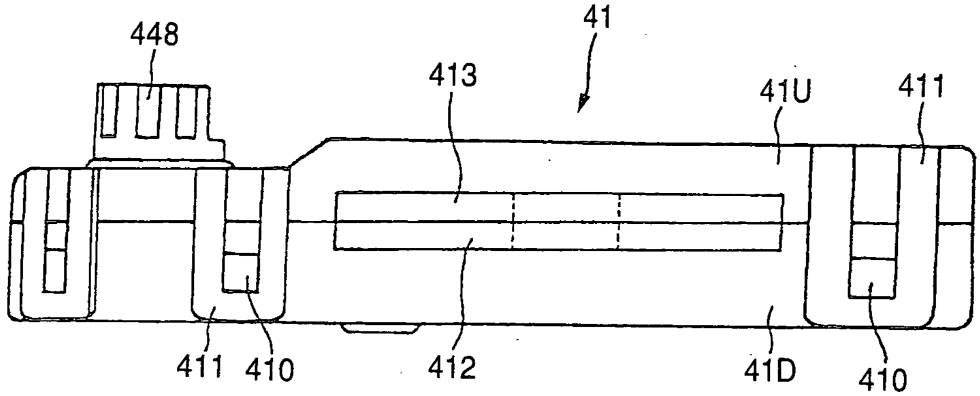

448
41
413
41U
411
411
410
412
41D
410

FIG. 9

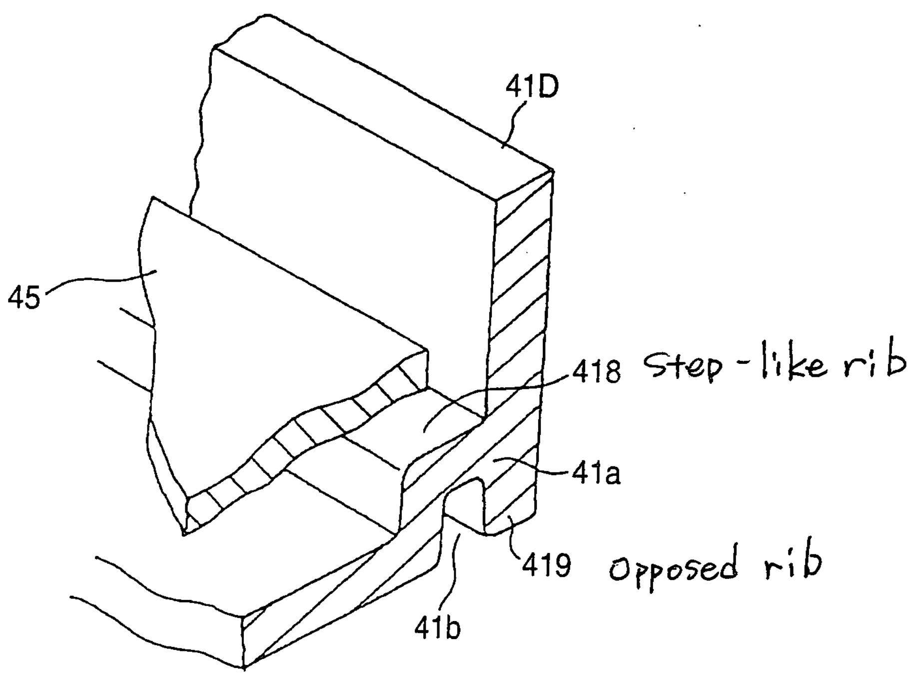
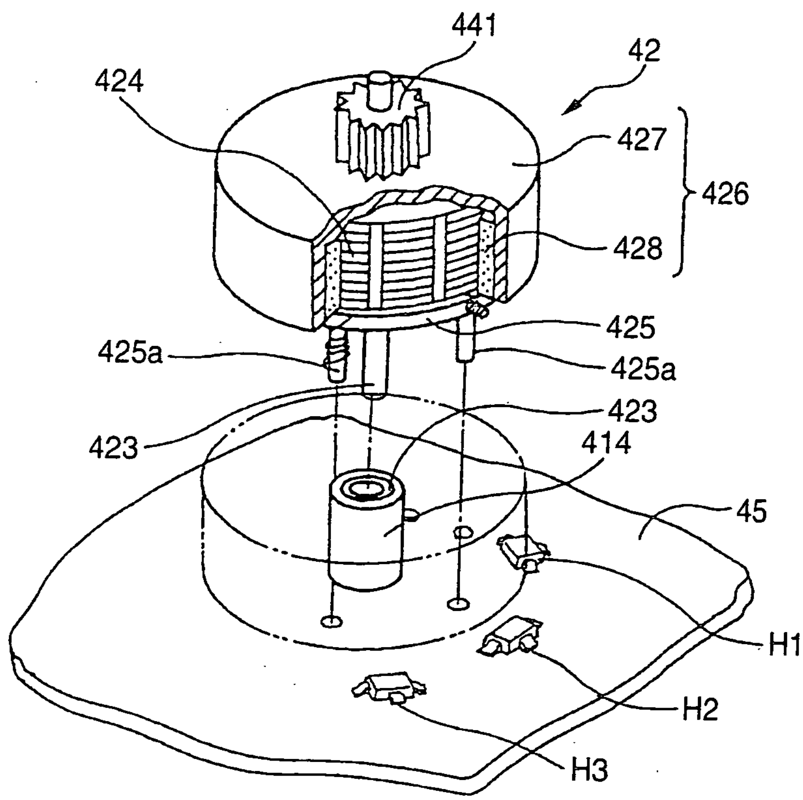
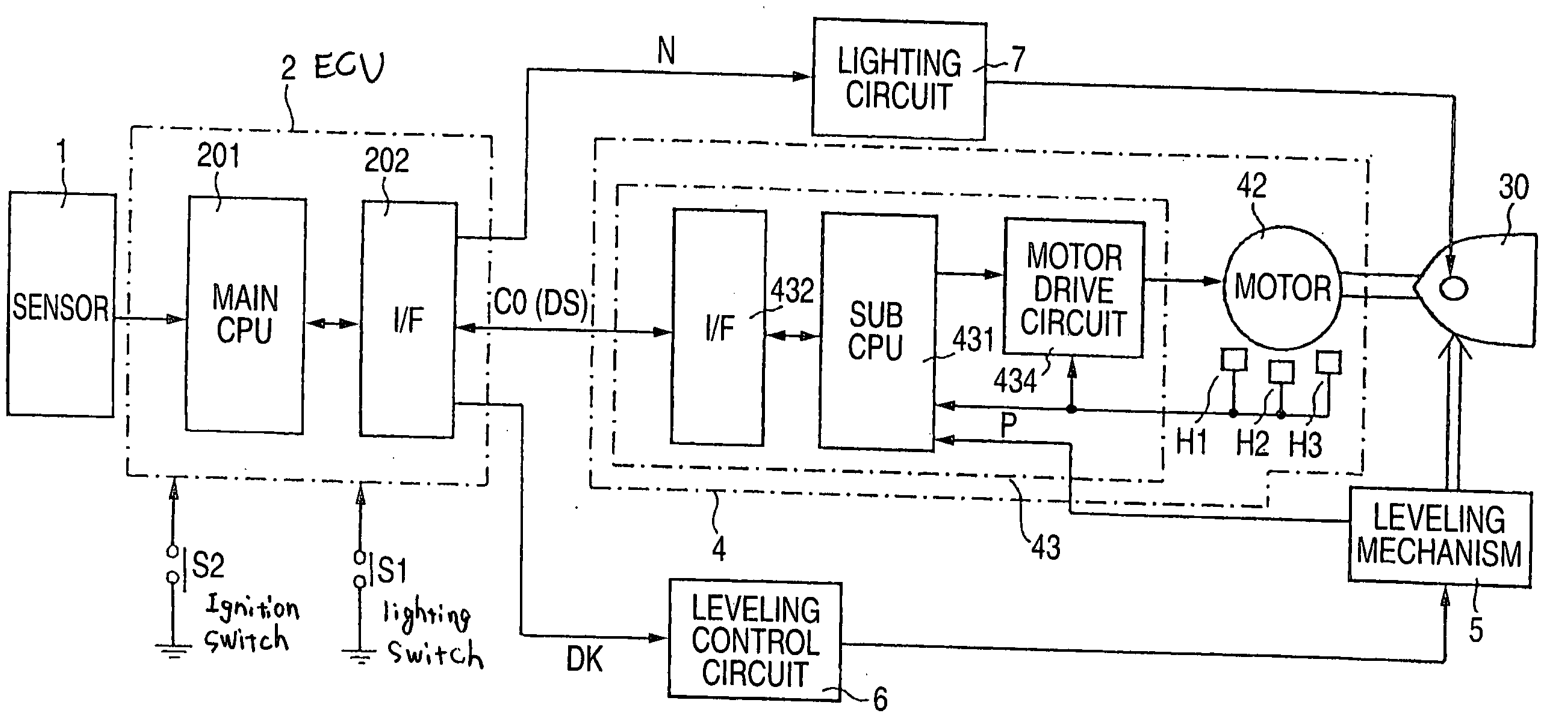

41D
45
418 Step-like rib
41a
419 Opposed rib
41b

FIG. 10



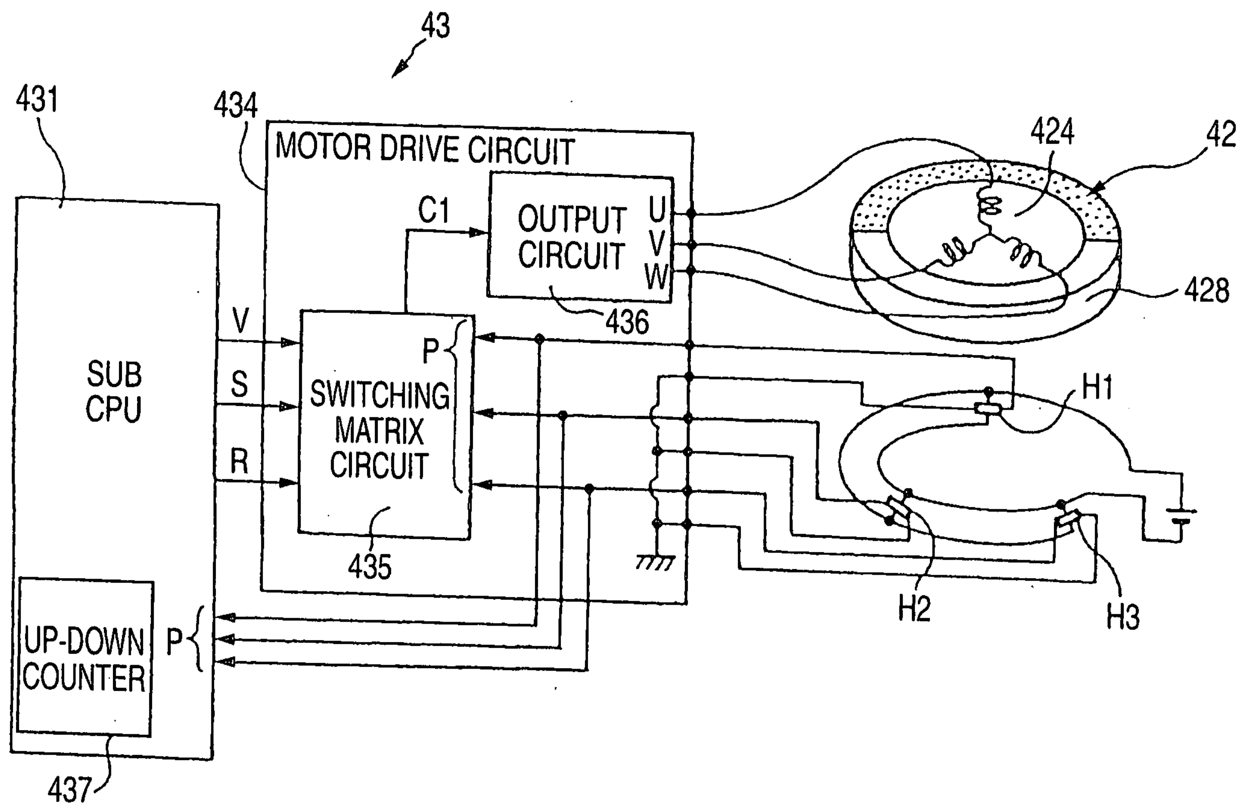
H1, H2, H2 : Hole IC

FIG. 11



SENSOR
1
2 ECU
201
MAIN CPU
202
I/F
S2
Ignition switch
S1
lighting switch
N
LIGHTING CIRCUIT
7
C0 (DS)
DK
LEVELING CONTROL CIRCUIT
6
I/F
432
SUB CPU
431
MOTOR DRIVE CIRCUIT
434
P
MOTOR
42
H1
H2
H3
4
43
30
LEVELING MECHANISM
5

FIG. 12


43
431
434
MOTOR DRIVE CIRCUIT
C1
OUTPUT
CIRCUIT
U
V
W
436
SUB
CPU
V
S
R
P
SWITCHING
MATRIX
CIRCUIT
435
UP-DOWN
COUNTER
P
437
424
42
428
H1
H2
H3